

REMARKS/ARGUMENTS

The examiner is thanked for thoroughly reviewing the subject patent application. Applicants wish to point out the major features of their claimed invention, which is an MTJ MRAM cell design with a shape and easy magnetization axis direction that, in combination, eliminates random variations in cell switching coercivities normally due to uncontrollable edge defects and the curling of magnetization vectors around the cell periphery.

The design of the claimed cell provides two performance enhancing features that are not found in other cells. These features are: 1) a narrow central cell portion in which defects (nucleation sites for field switching) are much more likely to be found than at the broader cell edges and, 2) magnetization vectors within the cell layers that are directed so as to produce a “fanning mode” configuration (the vectors come together in a head-to-tail fashion) at the laterally opposite edges of the cell. The particular improvements in performance produced by these features include stability-enhancing cell-to-cell coupling, ease of state switching and the elimination of defects from edge regions where their presence is uncontrolled and extremely disadvantageous. These improvements are more fully discussed in the Application.

The fanning mode (illustrated in Fig. 2b of the Application) is not energetically favorable, but it is intentionally produced by the cell design of the present claimed invention. The more energetically favorable mode of magnetization at the cell edges is the “curling” mode (illustrated in Fig. 2a), in which the magnetization vectors curl around the cell periphery in an attempt to produce the more energetically favorable closed loop configuration that does not have uncompensated poles. The fanning mode is achieved in the present claimed invention by combining the narrowed-middle cell shape with a longitudinally directed easy axis of magnetization. This combination produces a magnetization vector that passes longitudinally through the narrowed center (illustrated in Fig. 2b) and then fans out at the broader peripheral edge regions.

Examiner notes that Kishi et al. (US Patent Application 20020130339) also discloses an MRAM cell with a narrow central portion (illustrated, for example, in Kishi’s Fig. 2) that appears similar in its planar shape to the cell in Fig. 2b of the present Application. Yet there is a critical difference that is not evident if only the shape of Kishi’s cell is examined. Kishi’s cell requires an asymmetric placement of its easy axis of magnetization if the cell’s purpose is to be achieved. In fact, Kishi’s cell is designed to produce the curling mode of magnetization, rather than the fanning mode of the present invention. In short, while the two cell shapes appear similar, the cells, themselves, are not. This is because different alignments of the easy axis of magnetization creates entirely different behavior of the present claimed cell and the cell disclosed by Kishi. Kishi states in paragraph [0077]: “ In addition, the plane shape shown in FIG 2 is not symmetric to the straight line in FIG 2 indicating an easy magnetization axis of the ferromagnetic layer 20. In the ferromagnetic layer 20 of the

above-described shape, an S-shaped magnetic domain structure is formed and stabilized, whereby the switching magnetic field is substantially reduced.” Thus Kishi et al. achieve a reduced switching field by producing a non symmetric placement of an easy axis within a narrowed-center cell shape, thereby producing a curling mode (Kishi’s “S-shaped magnetic domain structure”). The present claimed invention produces a fanning mode within a narrowed center cell shape having a symmetrically placed easy axis of magnetization.

Having thus briefly explained the present claimed invention and contrasted it with the teaching of Kishi et al., Applicants would like to address the specific objections raised by the Patent Examiner.

Claim Rejections- 35 USC 103

Applicants respectfully request reconsideration of the rejections of amended claim 16 as being unpatentable over Kishi et al by arguing that Kishi teaches narrowed-middle cell structures having non-symmetric placement of an easy axis of magnetization relative to the direction along which the middle of the cell is narrowed, while the present claimed invention discloses a cell with an easy axis that must be directed along the narrowed middle (or, alternatively, perpendicular to the dimension in which the cell is narrowed). This distinction is significant in that Kishi et al. is thereby teaching formation of curling modes of magnetization, whereas the present claimed invention teaches the fanning mode. Thus, Kishi is teaching away from the present claimed invention and the non-symmetric placement of an easy magnetization axis within a cell having a narrow middle

portion does not suggest the present claimed invention. Applicants have, therefore, amended claim 16 to recite the direction of the easy axis of magnetization, which distinguishes their claimed invention from that of Kishi.

Applicants also respectfully request reconsideration of the rejection of claims 17-18 as being unpatentable over Kishi et al. as applied to claim 16 and further in view of Nguyen et al. (US Patent Application 20040130936). Applicants reason as follows. The layers of the cell structure of claims 17 and 18, formed in accord with the method of claim 16, have a common magnetic anisotropy and direction of an easy axis of magnetization. Thus, the cell structures formed in accord with claims 17 and 18, when magnetized and shaped in accord with claim 16, can fulfill the objects of claim 16. This result is not suggested by Kishi taken together with Nguyen for the same reasons argued above in connection with claim 16.

Conclusion

The Examiner is thanked for thoroughly reviewing the application. All claims discussed above are now believed to be allowable. If the Examiner has any questions regarding the above application, please call the undersigned attorney at 845-452-5863

Respectfully submitted,



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